THE UNIVERSITY of TULSA

Office of Research & Sponsored Programs

Hydrate Flow Performance JIP

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Phase 1 Final Report

December 31st, 2003

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I. Background:

The Flow Assurance Loop (FAL) was constructed in 1999 and several tests were made by BP, CSM and Marathon before Marathon made a decision to terminate its flow assurance research program in late 2000. During the last quarter of 2000 Marathon decided to close the Littleton Facility. In January 2001, Marathon put out a RFP for relocation of the FAL facility and in June 2001 TU was selected from 6 proposals submitted. Several meetings were held with industry to discuss their flow assurance needs, especially those related to deeper and colder waters. These discussions with Industry showed that there was a greater immediate need to study oil systems than gas systems since gas systems have been studied for quite some time and are better understood than oil systems. To address these concerns, The University of Tulsa formed a Joint Industry Project in June 2002 that utilized the Flow Assurance Loop developed by Marathon, once moved from Littleton, Colorado to the University, to conduct focused experiments to better understand hydrate formation kinetics in live oil, water and gas systems using black oil systems with different chemistries and plugging tendencies. This report documents the construction phase and the shakedown testing phase and provides a roadmap for the next two years of experimental testing.

II. Phase I Study Results

1. Facility Relocation:

This facility was moved to Tulsa in June 2002 and reconstructed during the summer. Photographs of the construction as it progressed are attached in Appendix I. Utilities were put in place and equipment re-wiring were begun the 4th Quarter 2002 and completed in March 2003. Operation familiarization and shakedown tests were started the 2nd Quarter of 2003. The facility was commissioned in September 2003. These activities are shown in Figure 1.

An aerial view of the facility is shown in Figure 2. The facility is a 3 inch-diameter flow loop, mounted on an 80-ft long tilt table as shown in Figure 3. The flow loop is 160-ft long and has an operating pressure of 2,200 psig. A Leistritz multiphase twin-screw pump circulates the fluids with a velocity up to 15 ft/s (Figure 4) and can generate the various flow patterns typically encountered in subsea pipelines. The flow loop is fully jacketed and the flow loop temperature is controlled with glycol circulating inside the annulus space. A 20-ton chilling system is used for cooling purposes and a steam heat exchanger and steam coils are used for heating. The fluid addition systems (oil, water, gas, additives, solvents) are located inside the process equipment building (Figures 5 - 7). These systems are used to initially charge the flow loop with oil, water, additives and gas, as well as to add make-up gas during the hydrate formation process. The entire facility is remotely operated from a control trailer (Figures 8 and 9).

Besides the necessary safety instrumentation, the facility is equipped with pressure, differential pressure and temperature transducers at various locations along the loop. Drops in pressure are recorded to monitor the hydrate formation process; flowing pressure drops can be monitored for studies on slurries and hydrate transports. Four view ports and three gammadensitometers are available on the flow loop to visually observe the fluid distribution and hydrate structure and to monitor the fluid densities.

The flow loop can be operated in a circulation mode using the multiphase pump or in the rocking mode to simulate slugs and restart conditions. Cooling ramps can be programmed with the chiller to simulate pipeline cool down after shutdown; different cooling rates can simulate different insulation efficiencies. As hydrates are formed, gas is consumed and the loop pressure will decrease; the gas addition system has the capability of adding make-up gas to maintain a constant pressure in the flow loop, thus adding more gas to form more hydrates and eventually generate plugs. Should plugs occur, the flow loop can be depressurized and plug dissociation studies can be performed.

An additive addition system is used to study the effect of various inhibitors on the hydrate formation process. All recorded parameters provide information on the kinetics of hydrate formation/dissociation; an accompanying hydrate laboratory cell will provide additional data, making it possible to attempt scale up of existing and developed models to process conditions.

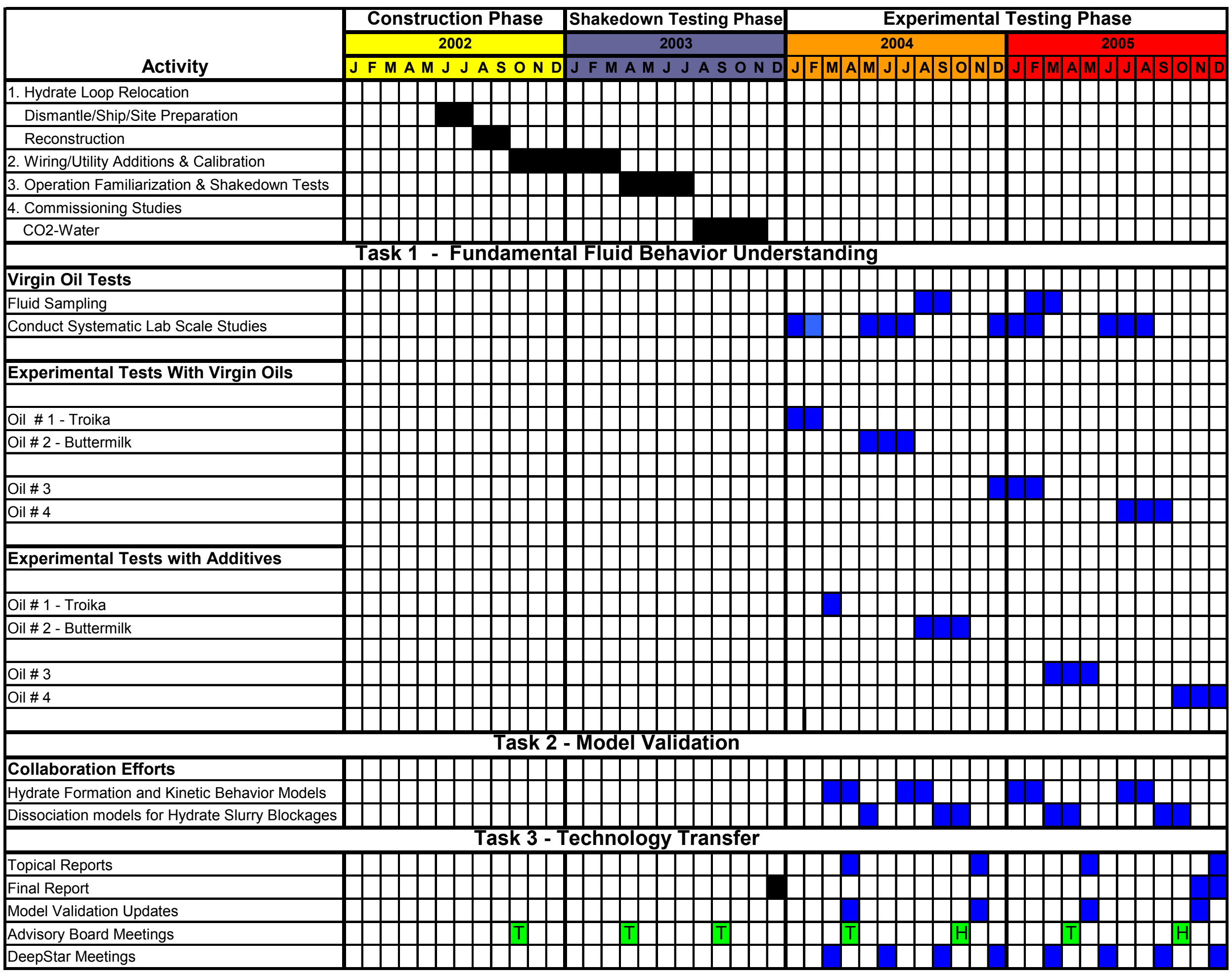

Figure 1: Project Task Chart

Figure 2: FAL Facility

Figure 3: Flow Assurance Loop Mounted on Tilt Table

Figure 4: Leistritz Multiphase Pump

Figure 5: Process Equipment Building

Figure 6: Gas Addition System

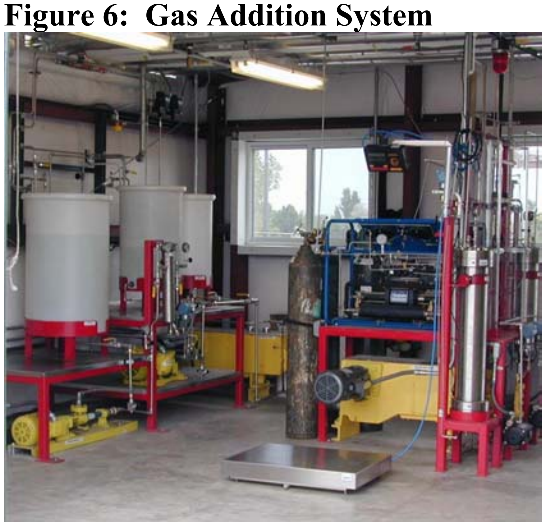

Figure 7: Process Equipment Building – Gas/Water Injection System

Figure 8: Control Trailer

Figure 9: Control Trailer Overlooking Flow Assurance Loop

Figure 10: 100 bbl Storage Tanks

In September 2003, the flow assurance loop was commissioned with CO_2 and water and the first hydrate tests were run successfully, leading to formation of a gas hydrate plug in the pipe. One test was run on September 16th and the second test was run as a demonstration during the Advisory Board Meeting tour September 30, 2003. The results of these tests are discussed below.

2. Experimental Procedure for CO_2 Hydrate Tests

For the first shake-down tests, carbon dioxide gas was chosen for the test fluid because of its ability to form hydrates, its high solubility in water and its non-hazardous nature. The flow loop was first loaded with water. Then carbon dioxide gas was added while rocking the flow loop up to a pressure of 600-800 psia. After the loop was pressurized, the coolant was circulated and the loop was cooled down to a temperature of 35 ^{0}F at an approximate cooling rate of 40 ^{0}F/hr.

Hydrate formation was indicated by gas consumption (the tests were run in a constant pressure mode), temperature increase and confirmed by visual observations and videos. After a couple hours, the hydrates were melted and the flow loop depressurized.

Test #1

Fresh water:	200 lbm
Initial gas charge:	40 lbm
Initial Loop Pressure:	620 psia
Make-up gas added:	17 lbm (rate 17 lbm/hr)

3. Experimental Results for CO_2 Hydrate Tests

Figure 11 shows the experimental results for Test #1. The chart shows the moment hydrate formation is initiated, indicated by an increase in the loop temperature at the end of the loop as well as by a constant gas consumption rate. After the hydrates were melted, one can also see that the final loop pressure was higher by about 150 psi. This increased pressure comes from the liberation of the gas that was continuously added during the test and consumed in the hydrate phase.

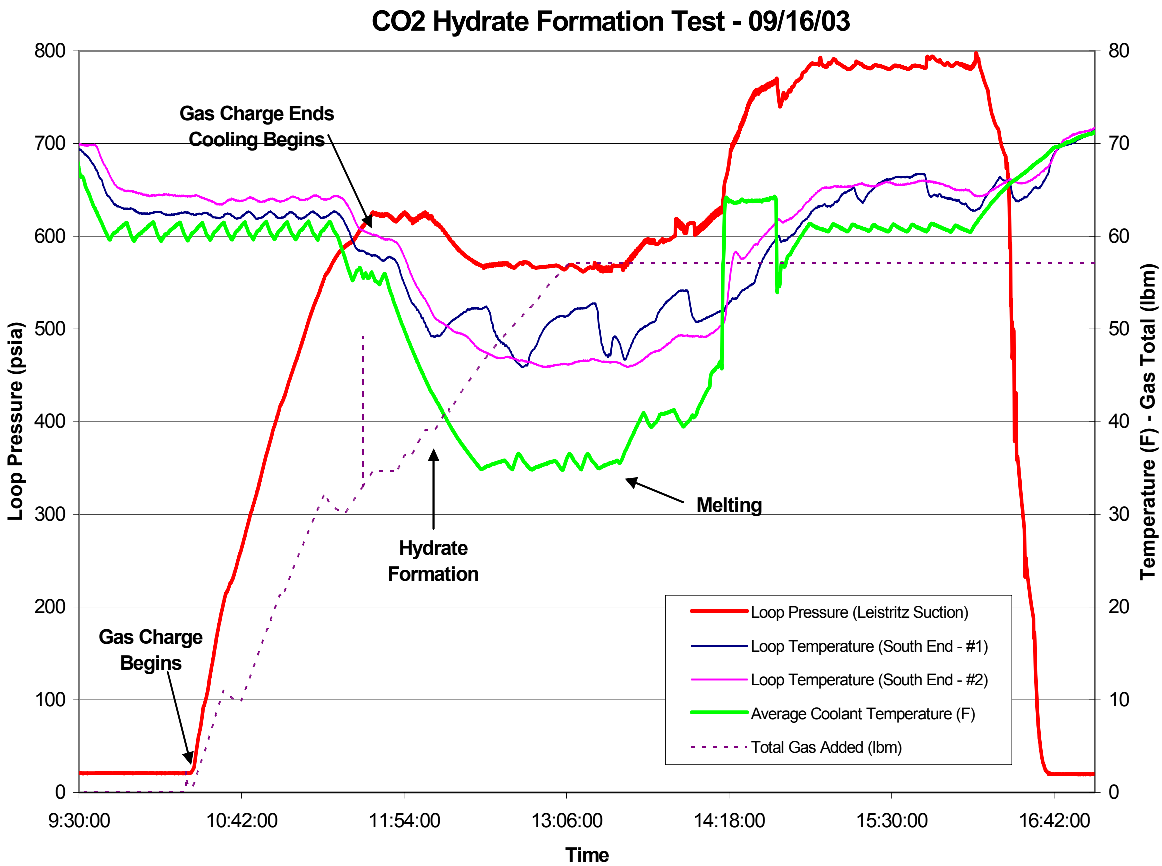

Figure 11: Experimental results for Test #1

Figure 12 below shows the pressure and temperature of the loop with respect to the phase envelope of carbon dioxide. On this chart the experimental hydrate formation point seems to be outside of the hydrate formation region. This is due to the location of the temperature probes, located on the outside of the inner pipe. Therefore the temperature inside the pipe is colder than the measured temperature during the cooling process and would be warmer than the measured temperature during heating. This difference due to heat transfer resistance between the inside and outside of the pipe must be kept in mind when trying to measure hydrate formation and dissociation points as the cooling and heating rates will have a direct impact on the results.

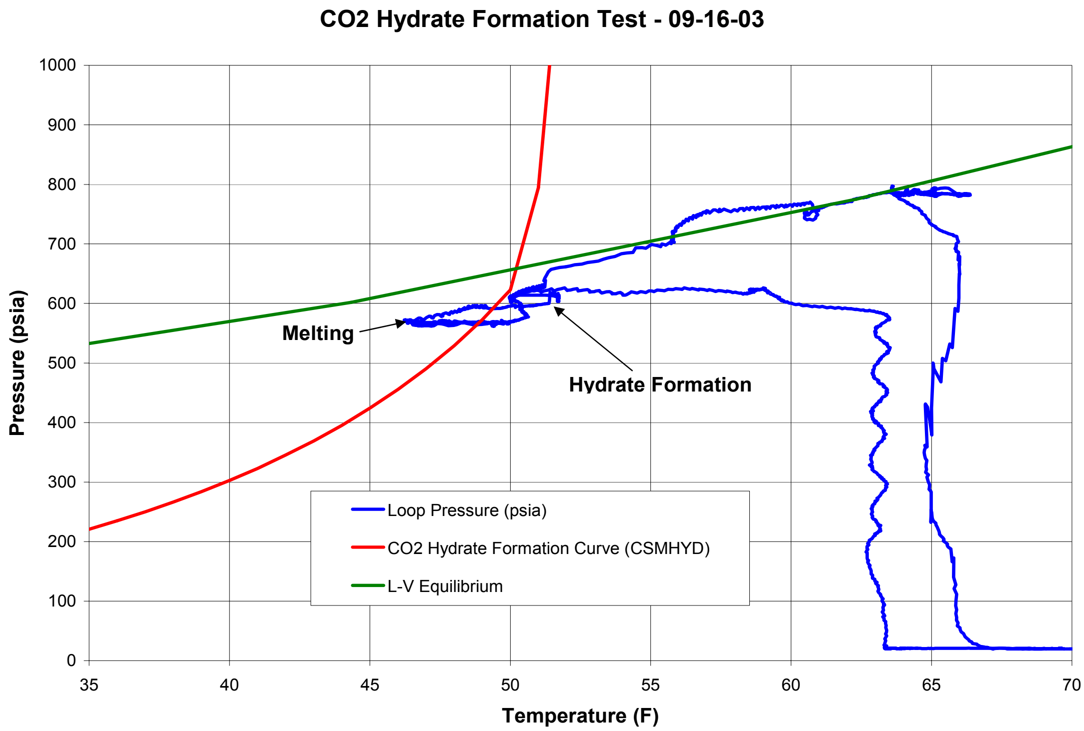

Figure 12: Test data locus on the P-T diagram

Visual observations confirmed the formation of hydrate plugs at the end of the flow loop where half to $2/3^{rd}$ of the pipe seemed to be plugged by hydrates depending on the location. Calculations also indicated that neither phase was depleted during this test and that the density of the formed hydrates was about 0.9.

Data from test #2 is not presented here since the test was conducted for demonstration purposes only. From visual observations only, this test, which was run at a higher starting pressure of 800 psia and with a larger water charge of 300 lbm seemed to have yielded more hydrates. We could not confirm this from the gathered experimental data.

4. Current Testing Activities

a. Facility operations

A crew of three operators has been formed and re-commissioning of the facility is taking place since it had to be winterized for winter. All the temperature and pressure probes have now been calibrated. Future steps include commissioning of the steam boiler and oil charge system, pressure testing of the flow loop at the maximum working pressure to ensure that the flow loop sustained no damage during the winter, insulation of the pressure lines and calibration of the liquid and gas charge systems.

Also, a storage slab with proper retention and stormwater treatment equipment is being constructed to allow storage space for the selected oils to be tested. These new additions are shown in Figure 13.

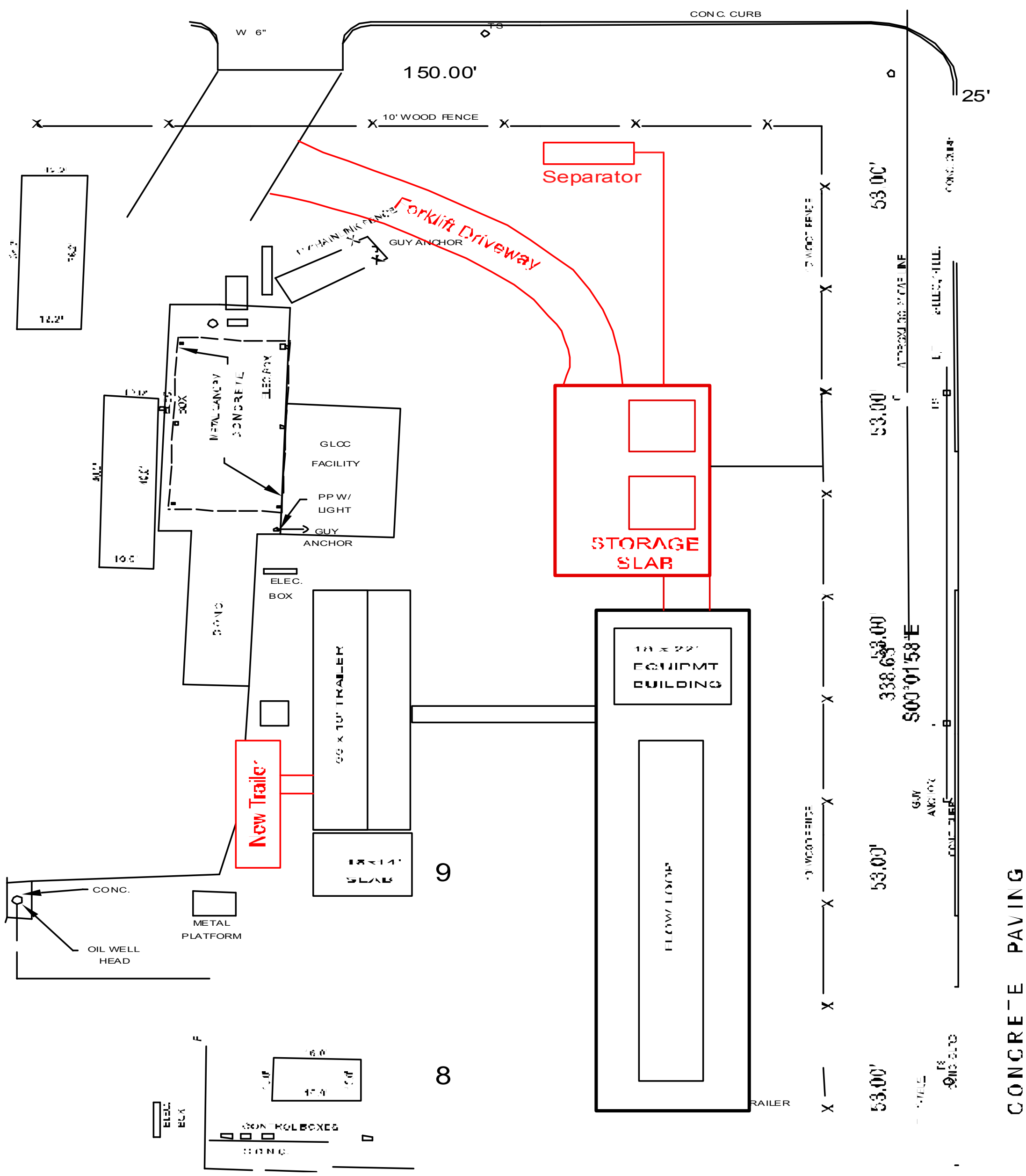

Figure 13: Facility Additions and Improvements

b. Oil Sampling:

Thirty one (55 gallon drums) of Troika and fifty one (55 gallon drums) of Arnold are currently on location for testing. Testing with Troika will begin in January 2004. Ten (55 gallon drums) of Buttermilk are being obtained from BP. They are due to arrive in Tulsa sometime during the first quarter of 2004. A meeting will be held with DeepStar's oil companies in January to pick the remaining two oil samples for testing.

c. Chemical Additive Selection and Testing

A meeting with the participating companies took place at BP headquarters in Houston on November 5, 2003. Conclusions of the meeting were that a generic base used for additive formulation would be used for the laboratory testing and flow loop testing. A proposed generic base was Armoclear 2550. Each chemical company would then perform testing with their own procedures using this generic base. This solution satisfied all the participants involved since it eliminates any commercial aspect out of the test program.

Five gallon samples of the Troika fluid were taken and sent to the participating chemical companies in December 2003.

III. Continuation Funding

On June 12, 2003 a presentation on the hydrate project was made to DeepStar Members regarding funding to conduct flow loop tests to provide benchmark data for kinetic model validation and rheological assessment of slurry flow. This information would expand the database of benchmark data beyond gas and gas condensate systems typically encountered in the deepwater Gulf of Mexico. In conjunction with Dendy Sloan of CSM, data from the study would be used their hydrate formation and kinetic behavior model as well as their dissociation model for hydrate slurry blockages. CTR 7204, championed by Norm McMullen of BP, was prepared and submitted. Funding in the amount of $375,000 was approved in December 2003. In addition to the DeepStar participants, two government agencies (DOE and MMS), Chemical Service Companies (Champion Technologies, Baker Petrolite and Nalco), other Universities (CSM), and other oil and gas companies that are not members of DeepStar (BHP) will participate. The current leveraging is approximately 1:1, but has potential to increase if other companies participate. The advisory board shown in Figure 14 shows the composition of the membership.

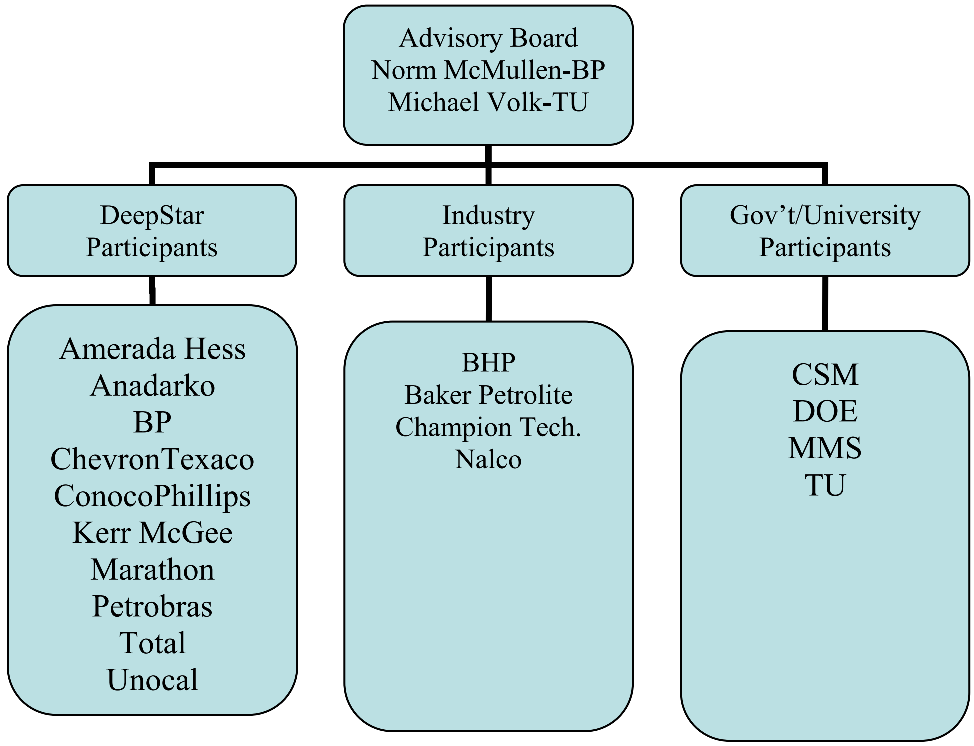

Figure 14: Advisory Board

IV. Scope of Work for Continuation Studies in Years 2004 and 2005

A flow loop test program series will be performed to provide benchmark data for kinetic model validation, and rheological assessment of slurry flow. This information will expand the database of benchmark data beyond gas and gas condensate systems typically encountered in the deepwater Gulf of Mexico. In conjunction with D. Sloan of CSM, data from this project will be used to validate their hydrate formation and kinetic behavior model as well as their dissociation model for hydrate slurry blockages.

a. Test apparatus

A 3 inch - 160-ft long flow loop will be used to conduct the experiments. This flow loop has been designed, constructed and operated by Marathon Oil Company and donated to the University of Tulsa. The proposed experiments will be tied into a Joint Industry Project on Hydrates Flow Performance to reduce project costs.

Pressure, temperatures and pressure drops are measured along the flow loop. Three densitometers and 4 sapphire windows will provide additional and visual observations. Hydrate particles morphology can be observed through the sapphire windows.

b. Test procedure

The flow loop will be charged with oil, water and gas at an initial temperature to be specified. A period of cooling and steady-state flow conditions will begin the test, followed by a 24-hour shut-in. The flow will then be restarted progressively at increasing rates. A step-up restart is recommended to determine the critical shear rate, since a restart at high rates may lead to shearing of hydrate particles during the process and affect test results at the lower rates. The step-up process prevents the shearing of the hydrate particles until flow is resumed. Tests will be conducted with and without additives. After each test, the flow loop will be cleaned and prepared for the next experiment.

For planning purposes, each test conducted with the above procedure is assumed to take 5 to 7 working days to complete, including test preparation and cleanup.

c. Approach and Work Plan

The tests will be conducted in Marathon's FAL that has the following characteristics: 2200 psia working pressure; 2.9-in. ID; 162-ft long flow loop; 20 tons of chilling; Leistritz multiphase pump with circulating rate yielding flow velocity of 15 ft/s; 4 sapphire, 1.5-in. diameter viewing ports; pressure, temperature and density instrumentation; and substructure that permits angle changes and rocking motion.

This facility will be utilized to gather large quantities of data to better understand hydrate formation kinetics in live oil, water and gas systems using four black oil fluids in subsea cold flow systems. Two oils will have low water cut plugging tendencies and two will have high water cut plugging tendencies. A low water cut plugging tendency oil, as defined by Shell, is one that is expected to form hydrate blockages at water cuts < 1%. For this study, low water cut oils are defined as those that will form blockage at water cuts < 10 – 20%. A high water cut plugging tendency oil is one that will not form a hydrate blockage until the water cut is in excess of 50 to 70%.

The strategy that will be used to solve this flow assurance problem is one that incorporates the hydrate modeling expertise of Dendy Sloan and his staff at the Colorado School of Mines and the Fluid Flow and Flow Assurance Loop Operation expertise of Jim Brill, Cem Sarica and Mike Volk and their staff at the University of Tulsa. It builds upon the ongoing work being performed for DeepStar and the Hydrate JIP at the University of Tulsa. Integration of this expertise with the experts within DeepStar in a collaborative effort will ensure that a high quality product will be delivered. This collaborative effort also involves the chemical service companies who will screen the additives that will be utilized in the study as well as determine how their lab tests scale-up.

The general approach will be to start the effort with a general workshop. During this workshop the test matrix will be discussed and modified if necessary to ensure the suite of tests conducted will generate the data necessary to understand the issues related to producing in the hydrate domain, during shutdown and restart of production systems, preventing hydrate formation and dissociating blockages.

The experimental tests will be modeled prior to initiation. Results from the experiments will be processed and evaluated continuously to guide the test program. Results will be reviewed regularly with the participants and input sought to result in an effective experimental and model validation program.

The project will focus on different hydrate production issues with the intent of providing valuable information to oil producers for a more economical approach of deep-water developments. These issues can be grouped into three categories:

> ***Producing in the Hydrate Domain*** - Most oil producers today take precautionary measures to avoid producing in the hydrate formation region (inhibitors, insulation), resulting in higher capital or operating costs. Considerable savings can be achieved through better understanding and confidence in the hydrate formation process under deep-water flowing conditions. The JIP will study the impact of different parameters, such as oil chemistry, salinity, water cut, cooling rates, multiphase flow patterns and subcooling, on the hydrate formation process. Qualitative information, such as morphology of the hydrates formed, and quantitative information on hydrate formation kinetics and transportation data will be generated from the flow loop tests.
>
> ***Shutdown and Restart of Production Systems*** - While designed to avoid the formation of hydrates under flowing conditions, deep-water systems become vulnerable if shut down occurs. Hydrates may form during the shut-in time as the temperature drops and plugging may occur on restart. The Marathon flow loop is very well suited to study the formation of hydrates under static conditions and study the restart process. Effects of shut-in time, cooling rates, water cut, salinity, and oil chemistry on hydrate formation and accumulation while restarting will be studied. In an attempt to provide information on the best strategies to restart plugged pipelines, dissociation data will be gathered, if and when, hydrate plugs occur.
>
> ***Preventing Hydrate Formation*** - Finally, many different additives or inhibitors can be used to prevent or delay the hydrate formation process, or to prevent accumulation of hydrate particles, eventually leading to the formation of a hydrate plug. More qualitative and quantitative information is needed on the performance of these chemicals under various conditions. The study of additives will be included in this project to identify the key parameters involved in the selection process and in their performance, and help oil operators and chemical companies improve their selection process.

V. Project Schedule and Milestones

The schedule for completing the complex and interrelated tasks is shown in Figure 15. The objective will be to develop an understanding of fluid behavior during well start-up and shut-in conditions to prevent flowline plugging during these operations. This understanding is expected to yield improved and safer operating procedures. It will also help in the most effective placement of chemical treatment systems. The kinetic model will also be validated and enhanced that will allow the industry to advance its understanding of the key factors in hydrate kinetics in industrial systems. The study will last two years, finishing in 2005. Figure 15 also shows when significant deliverables in the form of reports, model validations, and data will be provided to the participants. The tasks shown in Figure 15 were established based on industry feedback from several workshops with oil & service companies' representatives. Several parameters were identified as being of interest in the hydrate formation phenomena. These parameters are: Hydrocarbon composition/chemistry; Brine salinity or composition; Water cut (wc); Cooling rates; Flow patterns; Steady state vs. transient phenomena (shut-in/restart); Effect of chemicals; Shut-in duration; Subcooling; Pressure; and Temperature

To establish a test matrix, the interest in the above-mentioned parameters had to be prioritized, since it would be impossible to study the effects of all these variables within the timeframe of this study. There was a consensus among industrial participants that there is a more immediate need to study oil systems than gas systems, since gas systems have been studied for quite some time and are better understood than oil systems. Moreover, gas systems can be depressurized more easily than oil systems and the research effort therefore appears less critical than for oil production systems.

Proposed Hydrate Studies with Marathon Flow Loop

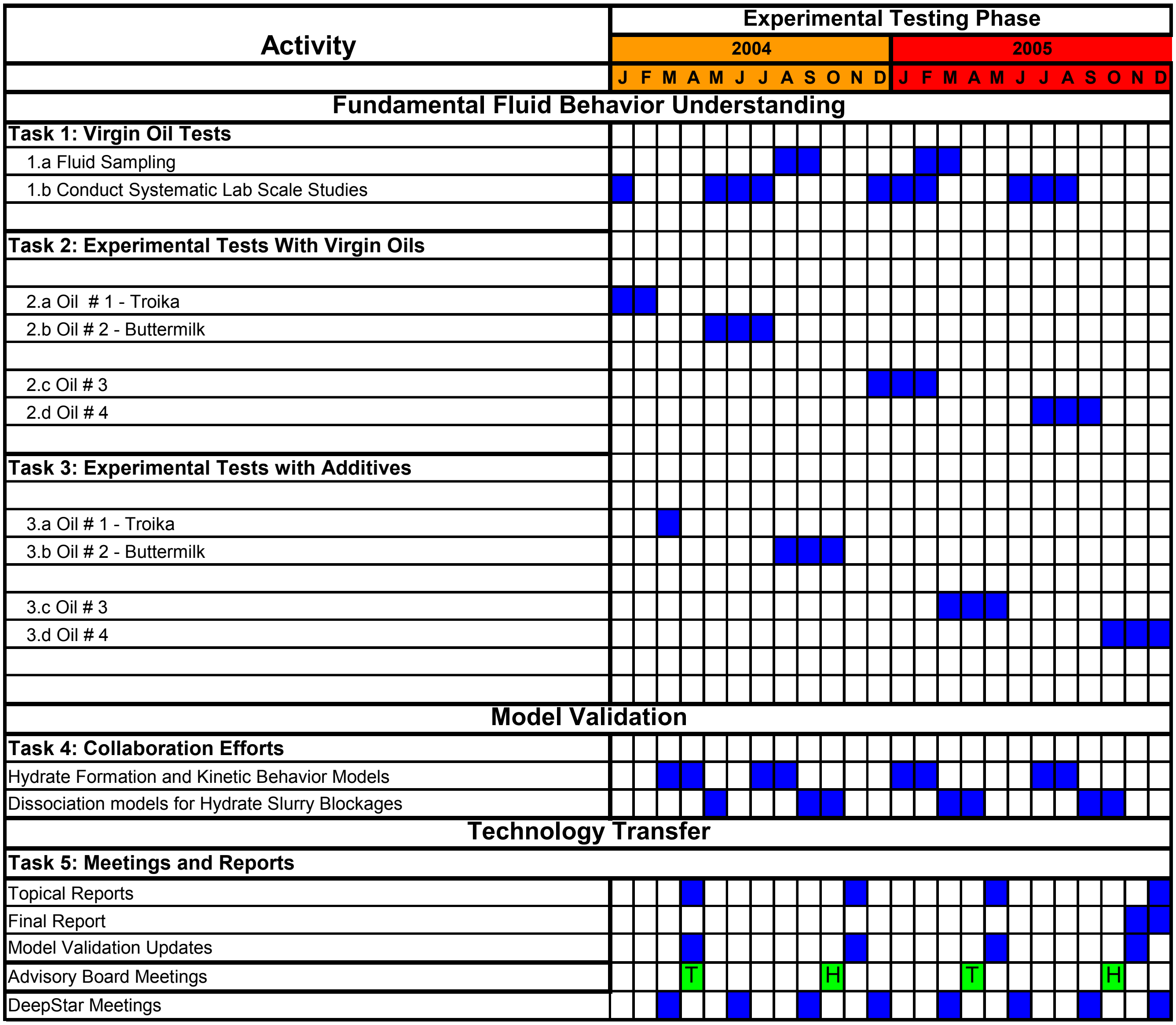

Figure 15: Proposed Hydrate Studies Gantt Chart

Task 1 - Virgin Oil Tests - Oil chemistry plays an important role in the hydrate formation process. In order to gather data on different types of crude oils, four types of crude oils will be selected. It is believed that the amount and type of surfactants present in the crude will play an important role in the transportability of the hydrate solid phase. Focus will be made on wax and asphaltenic properties, as proposed in Table 1 below:

Types of Oils	WAX	Asphaltenes
Low Water Cut Plugging Tendencies		
First crude	Low	Low
Second crude	High	Low
High Water Cut Plugging Tendencies		
Third crude	Low	High
Fourth crude	High	High

Table 1: Effect of Oil Chemistry

Subtask 1a - Fluid Sampling - Four fluids will be studied. Two will have low water cut plugging tendencies and two will have high water cut plugging tendencies. Participants will be queried for donation of potential fluids. Fifty (50) barrels of Troika are currently available in house. Ten (10) barrels of Buttermilk are currently being taken and are scheduled to arrive in Tulsa the first quarter of 2004. Donation of two additional crude oils will be sought from the Participants. At a minimum, 10 barrels of fluid should be taken and sent to the University of Tulsa for utilization in the study.

Subtask 1b - Conduct Systematic Lab Scale Studies – Collaboration efforts have been established with the chemical service companies not only because of their expertise in oil field chemistry issues but because they will be the manufacturer/distributor of the anti-agglomerants. A committee has been formed with the industrial participants to systematically identify modeling/experimental tasks that probe into what in the oil is responsible for non-plugging behavior. The four selected candidate oils with known plugging and non-plugging tendencies will be analyzed. SARA data, oil-water IFT data, resin/asphaltene ratio, wax content, natural surfactant content, emulsion forming tendencies, etc. for the oils will be measured to see if there are any correlation(s) to plugging tendency. The answer to this issue is in the oil phase and this effort will progress under that assumption.

Subtask 1c - Deliverables - The deliverable would be a report on the experimental findings, any correlations identified and conclusions.

Task 2 - Experimental studies: Discussed below is a description of the proposed test matrix. Table 2 below summarizes the different fluid charges considered to study the effect of water cut and cooling rate at one salinity. Three different water cuts will be studied for each oil. Low water cut tests range from less than 1% water up to 15%; high water cut tests are defined as 50% water and higher. Medium water cut tests are considered to have water cuts between 20 and 40%. Two additional tests will be conducted to study the effect of "long-term" shut-in time on the hydrate formation and flow restart processes.

	Water cut			Cooling rate		Test procedure		Long shut-
Test #	< 15%	20-40%	80%	5 F/hr	40 F/hr	Cte V	Cte P	in time
1	X			X		X		
2	X			X			X	
3	X				X	X		
4	X				X		X	
5		X		X		X		
6		X		X			X	
7		X			X	X		
8		X			X		X	
9			X	X			X	
10			X		X		X	
11		X		X			X	X
12		X			X		X	X

Table 2: Fluid Charges

Subtasks 2a – 2b – Flow Loop Tests to Generate Benchmark Data - Tests 1 to 10 are designed to investigate hydrate formation with the virgin oils with increasing water cuts. The purpose of these tests is to 1) study the effect of water cuts and cooling rates on the hydrate formation process, 2) generate different kinetic data by running constant volume and constant pressure tests, and 3) serve as a reference for additive performance tests and lab tests comparisons.

For each of the three water cuts considered, hydrate formation tests will be conducted at two different cooling rates to simulate insulated vs bare pipe conditions. For each fluid charge, constant volume tests will be run first; hydrates will then be melted and the last test will be a constant pressure test. When conducting a constant pressure test (i.e. with continuous gas addition), it is necessary to vent the gas when melting the hydrates in order to not exceed the maximum operating pressure of the flow loop. This venting will modify the composition of the system, and therefore the charge should be replaced after such a test. The possibility of conducting consecutive tests at a constant pressure without re-charging the flow loop will be discussed with the participants. Should this possibility be accepted, more tests could be conducted within the same time frame.

Test 11 and 12 will focus on longer shut-in periods followed by increasing pumping rates to determine any critical shear rate of the hydrates. Constant pressure tests are more representative of this type of situation.

It will take a minimum of two months to complete experiments 1 to 12. To account for repeat tests and possible dissociation studies, three months is allotted. The study of four oils will take approximately one year leaving one year for the studies with additives. Maintenance and shutdown times have been estimated and included in the test matrix. Since tests will be run consecutively, it is necessary to insure that any problems with the facility or the instrumentation be fixed before proceeding to the next experiment. This is only possible if the data are processed immediately after each experiment. Data processing will be performed between experiments, especially during the hydrates dissociation, cool down, cleaning and charging phases. Simulations with existing models will be run for comparisons of experimental results and predictions of other experiments.

Subtask 2e - Deliverable (Report) - The tests conducted in the JIP will provide a large database on hydrate formation and growth kinetics as well as their transport. From this database, model enhancements may be derived. A report on the experimental findings, model validations and enhancements and conclusions will be provided.

Tasks 3 - Experimental Tests with Additives - Following each virgin oil test, tests with additives (anti-agglomerants) will also be conducted. The purpose of these tests are to (1) identify parameters of importance in the selection of additives, (2) identify operating limits with respect to water cut and salinity for the additive, and (3) compare the flow loop results with the laboratory results. For each crude oil, participating chemical companies will conduct screening tests (rolling ball and autoclave) using a generic additive.

Subtasks 3a – 3d – Flow Loop Tests with Additives - Discussed below is a description of the proposed test matrix for the flow loop additive tests. Table 3 below summarizes the different fluid charges considered to study the effect of water cut, salinity and additive concentration.

	Water Cut		Salinity			Concentration		
Test #	<15%	20-40%	Base	Max.	>Max.	High	Low	Cte P
1	X		X			X		X
2	X		X				X	X
3	X			X		X		X
4	X				X	X		X
5		X	X			X		X
6		X	X				X	X
7		X		X		X		X
8		X			X	X		X

Table 3 Test matrix for Additive Studies

All the tests will be run at constant pressure conditions. Two series of four tests will be conducted using a low and a medium water cut. For each water cut, tests will be conducted at a base case salinity, at the maximum salinity and subcooling conditions under which the additive is claimed to be efficient, and at a salinity greater than the maximum salinity. The goal of these tests is to help identify parameters of importance in

the selection of additives and to compare the flow loop results with laboratory results conducted by the participating chemical companies. The final test matrix will be subject to modifications based on previous results and discussions with the participants. Modifications or extensions of the test matrix will be discussed and approved by the Committees. Additive tests are planned on all four oils.
Subtask 3e - Repeated tests with chemicals will demonstrate the inhibition effects of the chemicals selected. A report on the experimental findings and conclusions will be provided.

Task 4 - Collaboration Efforts - Collaboration efforts with Dendy Sloan at the Colorado School of mines have been established. Data from the flow loop experiments will be used to validate their hydrate formation and kinetic behavior model as well as their dissociation model for hydrate slurry blockages. Collaboration efforts with CSM will be sought where data from the project will be exchanged to further validate their models for the right to use them in this study. The test data may also point out improvements that could be made to the models. Should improvements be identified, they will be incorporated into the model.

Subtask 4a - Deliverables - The deliverable would be a report on the model validation results and any enhancements identified. Data for the four donated fluids would be utilized as a check of the model predictions vs. data. A report on the model findings and conclusions will be provided.

Task 5 – Technology Transfer – Technology transfer will occur through several means. There will be four semi-annual advisory board meetings; two in Tulsa and two in Houston. Presentations will also be made at the quarterly DeepStar meetings. A topical report will be provided upon completion of testing with each fluid that will also include the findings from the model validation updates.

VI. Future tests

Attention is being given now to the former tests performed at MOC with the Troika fluid. A test matrix with the Troika fluid will be developed shortly and submitted to the participants for review. After approval of the Troika test matrix, the testing program will begin.

VII. Future Meetings

The next advisory board meeting is scheduled for March 30, 2004. The meeting will be held in the Alan Chapman Activity Center (ACAC) at the University of Tulsa from 9 am to 3 pm. A tour of the facilities will be held at the North Campus from 3 to 5 pm. A BBQ dinner will be held after the tour.

VII. Appendix - Photos of Facility Relocation

Transportation of Facility

Chilling System

Storage Tanks

Storage Tanks

Tilt Table Arriving

Tilt Table Arriving…

Tilt Table Arriving…

Tilt Table Arriving…

Tilt Table Arriving

Control Trailer Arriving

Process Trailer Arriving

Process Building Arriving

Control Trailer

Unloading of Facility

Unloading Chilling Unit

Crane Used for Lifting

Crane Used for Lifting

Tilt Table Unloading

Tilt Table Unloading

Tilt Table Unloading

Tilt Table Unloading

Tilt Table Unloading

Control Trailer Unloading

Control Trailer Unloading

Control Trailer Unloading

Control Trailer Unloading

Control Trailer Unloading

Process Trailer Unloading

Process Trailer Unloading

Process Building Unloading

Process Building Unloading

Process Building Unloading

Process Building Internals

Excavation for Pads for Process Building and Flow Loop

Excavation for Pads for Process Building and Flow Loop

Framing of Pad for Flow Loop

Installation of Pipe Racks

Pouring of Pad for Flow Loop

Pouring of Pad for the Flow Loop

Installing Rocker Arms

Moving Knockout Tank

Knockout Tank in Place

Setting Tilt Table

Setting Tilt Table

Setting Tilt Table

Installing Chilling Unit

Overall View of Facility

Overall View of Facility